CHAPTER 6

CRATES

INTRODUCTION TO CRATES

NOMENCLATURE AND RELATED TERMS

Crates are rigid containers constructed of structural members fastened together to protect the contents. Crate design involves numerous names and terms which must be defined if the construction of crates is to be explained without confusion. When the names of the separate components are known, although they differ in various specifications and drawings, their functions and relationship to each other are more easily understood. In order that both general and detail design requirements may be clearly understood, reference to items described in ASTM D 996 and below is recommended.

Nomenclature

Baffle

A piece of plywood, wood, or metal placed over ventilation holes to deflect air or water entering the crate.

Bottom Sheathing

Boards nailed to the bottom surface of the frame members of a sill base. Also known as flooring.

Bridging

Members of the same depth as joists or sills placed at right angles to the intermediate longitudinal or crosswise sills or headers to prevent lateral turning or buckling of the joists or sills.

Cleats

Auxiliary reinforcements for plywood panels placed between vertical struts to strengthen the panel.

Covered Crate

A crate with open-type frame with an outside covering of plywood or paper-overlaid veneer.

Crate Base

The bottom load bearing unit of a crate.

Crate Covering

A lightweight material fastened to the frame of an open crate to give more positive weatherproofing than is offered by an open crate and shroud.

Diagonals

Frame members positioned between parallel frame members and placed at angles of nearly 450 to the latter.

Diagonal Floorboards

Usually 1-inch boards, cut at 450 angle to the skids and placed between the forklift areas.

End Frame Members

Members of the top panel of an open crate, placed crosswise at each end of the top.

End Sills

Members forming the ends of a sill frame.

Filler Strips

Boards placed across the ends of thin, nonload bearing floorboards which fill the space below the lower frame member of the sides.

Floor Members

Boards and timbers nailed or bolted to the top of the skids forming a platform for the contents and a bottom closure for the crates.

Forklift Area

Area extending 42 inches in from each end of the crate, usually floored with 2-inch boards.

Frame Members

Those wood members which form the fundamental structure of the crate.

Gusset Plate

A square piece, usually plywood, placed at the junction of the diagonals for reinforcement.

Hanger, Metal

Metal strapping formed in a manner to support intermediate sills on a sill-type crate or joists of the top.

Headers or End Cross Members (Open Crate)

Cross members attached at the end of the skids which hold the skids together. Also longitudinal members at each end of top joists.

Horizontal Braces

Members positioned between struts and parallel to upper and lower frame members of the sides or ends.

Horizontal Top Bracing Joist Support

Horizontal member attached to the frame members in which the top joists rest.

Intermediate Crosswise Sills

Full length members located between the end sills and parallel to them.

Intermediate Frame Members

Members of the top panel of an open crate located between and parallel to the side frames of the top.

Intermediate Longitudinal Sills

Full length members located between the side sills and parallel to them.

Intermediate Skids

Full length beams located between and parallel to the skids.

Joists

Members extending across the crate that support the top and prevent crushing when grab hooks are used.

Joists Supports

Members, usually 2 x 4, nailed to the frame under each joist and extending to the floor.

Kick Blocks

Short members attached at the junction of the corner post and upper or lower edge member. They are used on end panels having no braces or those with a single diagonal brace.

Lag Bolt Reinforcing Strap

Galvanized strapping drilled to take lag bolts and nailed to the inner face of the sheathing at the center line of the skid and header.

Load Bearing Floor Members

Heavier or reinforced floorboards used to hold the concentrated weight of the crate load.

Lower Frame Member

Horizontal frame member at the lower edge of the side and end panels. Formerly called lower edge member.

Open Crate

A crate formed of frame members only, without exterior sheathing attached.

Reinforced Straps

Metal strapping applied at the corners or base corners to reinforce and fasten the panels together.

Rubbing Strips

Boards nailed to the underside of skids or bottom sheathing.

Sheathed Crate

A crate in which the frame members are completely covered with sheathing.

Sheathing

Material such as plywood, lumber, or fiberboard nailed to the frame of a crate across all openings to add strength to the crate, or to prevent loss of contents, pilferage, or entry of dirt, water, etc., into the crate.

Side Frame Members

Members of the top panel of an open crate, placed lengthwise of each side of the top.

Side Sills

The members forming the sides of a sill base crate.

Sills

The continuous frame members of a sill base.

Sill Base

A crate which has its frame members (sills) built on the inside of the crate to which the bottom sheathing is attached.

Sill Bridging

Members of the same depth as the sills placed at right angles to the intermediate lengthwise or crosswise sills of a sill base to prevent twisting or buckling.

Skids

The outside longer beams of a skid base which support the weight of the crate and contents.

Skid Base

A crate base which has its longer beams on the outside.

Sleeper

Reinforcing members secured to the underside of the floorboards, at right angles to the floorboards to provide secure anchorage for the item.

Spacers

Members which position the ends of joist or sills.

Spreaders

Members placed at right angles to the floorboards, between the item and the floorboards, to distribute the load over a wider area.

Sling Notches

Open spaces between the ends of the rubbing strips and the ends of the crate, or cutaway sections at the ends of the skids.

Struts

Vertical frame members between the upper and lower frame members.

Top Joist Spacers

Short members nailed between the top joists, to the inside face of the upper frame members, which act as end bridging.

Top Sheathing

Board or plywood forming the closure of the top.

Upper Frame Member or Upper Edge Member

Horizontal frame member at the upper edge of the side and end panels.

Related Terms

Actual Size Lumber

The true dimension of a piece of lumber as measured with a scale.

Center of Balance

The point along the length of a crate at which it would balance on a fulcrum, placed at right angles to the skids of sills.

End Grain Nailing

Nails driven parallel to the grain of the wood.

Gross Weight

Total weight of the crate and its contents when ready for shipment.

Holddowns

Devices constructed of wood or metal, used to secure the item to the base of the crate.

Liner

Waterproof barrier material placed between the frame and the sheathing.

Net Weight

The weight of the item alone, excluding dunnage, wrappings, or containers.

Nominal Size Lumber

Dimension of lumber before it is dressed.

Overdriving

Driving nails into wood so that the heads sink below the surface of the wood.

Side Grain Nailing

Nails driven at right angles to the grain of the wood.

Tare Weight

The weight of the crate, including dunnage, holddowns, and packing materials.

Underdriving

Driving nails into wood so that the heads protrude above the surface of the wood.

CLASSIFICATION OF CRATES

Crates are grouped into several categories. They may be open or sheathed (fig 6-1). Crates may be nondemountable, single trip crates of nailed construction, or bolted, reusable, demountable crates. Crates may be designed for domestic use only, or for both domestic and oversea shipments. Some crates are designed for general use and others are constructed in accordance with a specification for a particular item. Of course, the classification of a crate may include a combination of several of the above factors.

Open Crates

An open crate is a container formed of frame members only, without exterior sheathing attached. When plywood or paper-overlaid veneer is used to provide additional weather protection, they may be called covered crates as opposed to sheathed crates. The open crates discussed in this section are the most widely used (fig 6-2, 6-3, and 6-4).

Small Open Crates

Small open crates may be subdivided into the following categories:

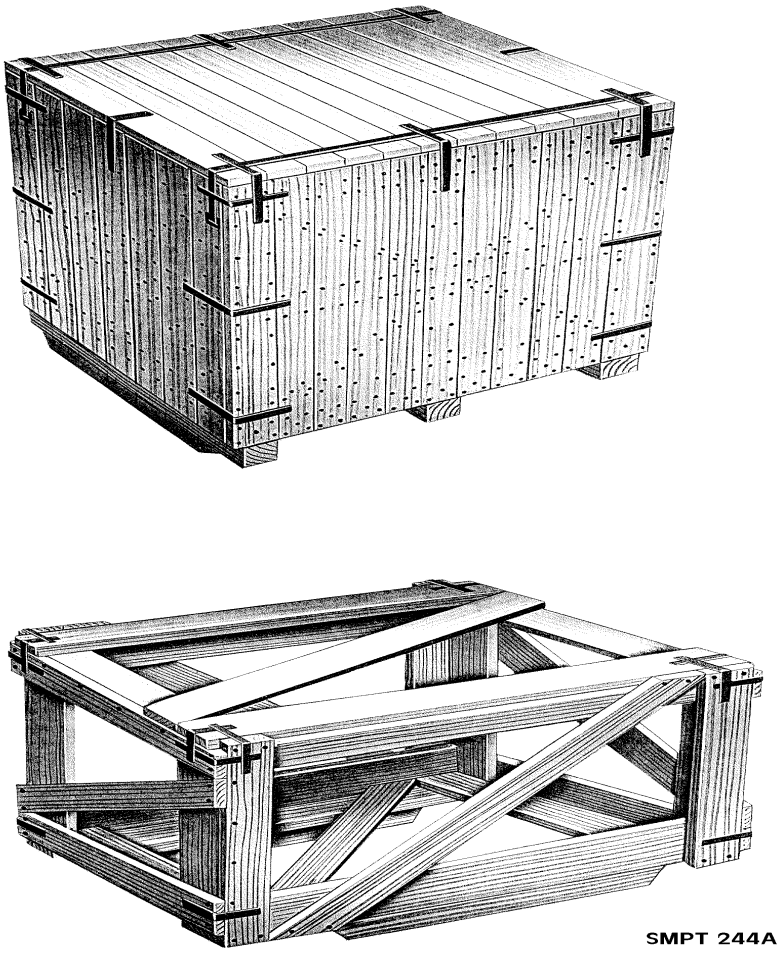


Figure 6-1. Open and sheathed crates.

Shallow Crates

These crates are normally not more than 12 feet in length, 4 feet in width, and 2 feet in height, as illustrated in figure 6-2. The net weight of contents should not exceed 1,000 pounds. However, there are exceptions to these requirements which are explained in the footnote of table 6-3.

Lightweight Crates

These crates are designed for net weight of contents not exceeding 250 pounds. The size is limited to 4 feet in length, 3 feet in width, and 3 feet in height (fig 6-2 and 6-3).

Medium Weight Crates

Crates in this classification are normally designed for a net weight of contents not exceeding 1,000 pounds. The size is limited to 6 feet in length, 4 feet in height, and 4 feet in width (fig 6-2).

Heavy Weight Crates

These crates are normally designed for a net weight not exceeding 4,000 pounds. The size is limited to 32 feet in length, 6 feet in width, and 10 feet in height (fig 6-2, and 6-3, Type V).

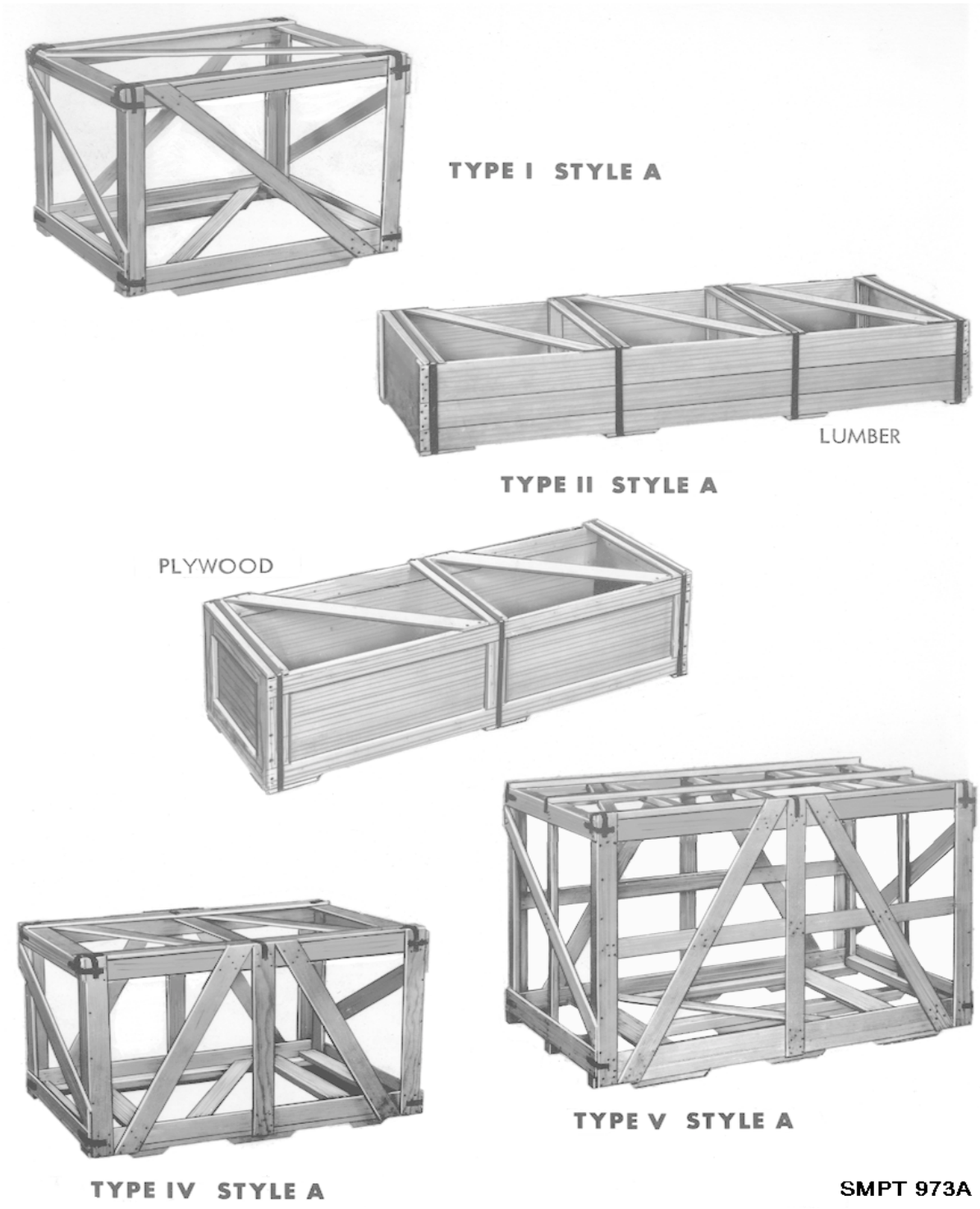


Figure 6-2. Styles of open crates (MIL-C-52950).

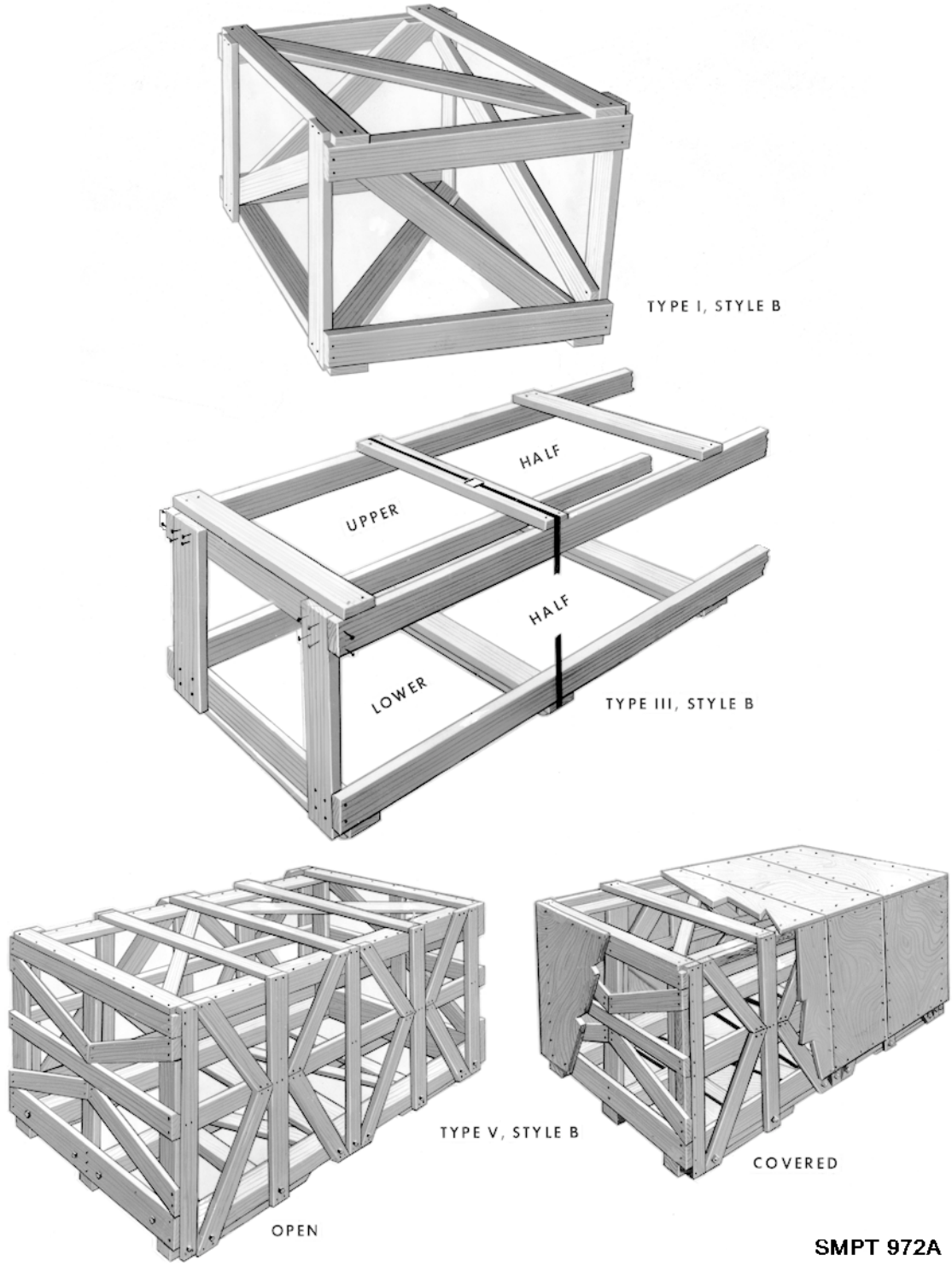


Figure 6-3. Styles of open crates (MIL-C-52950).

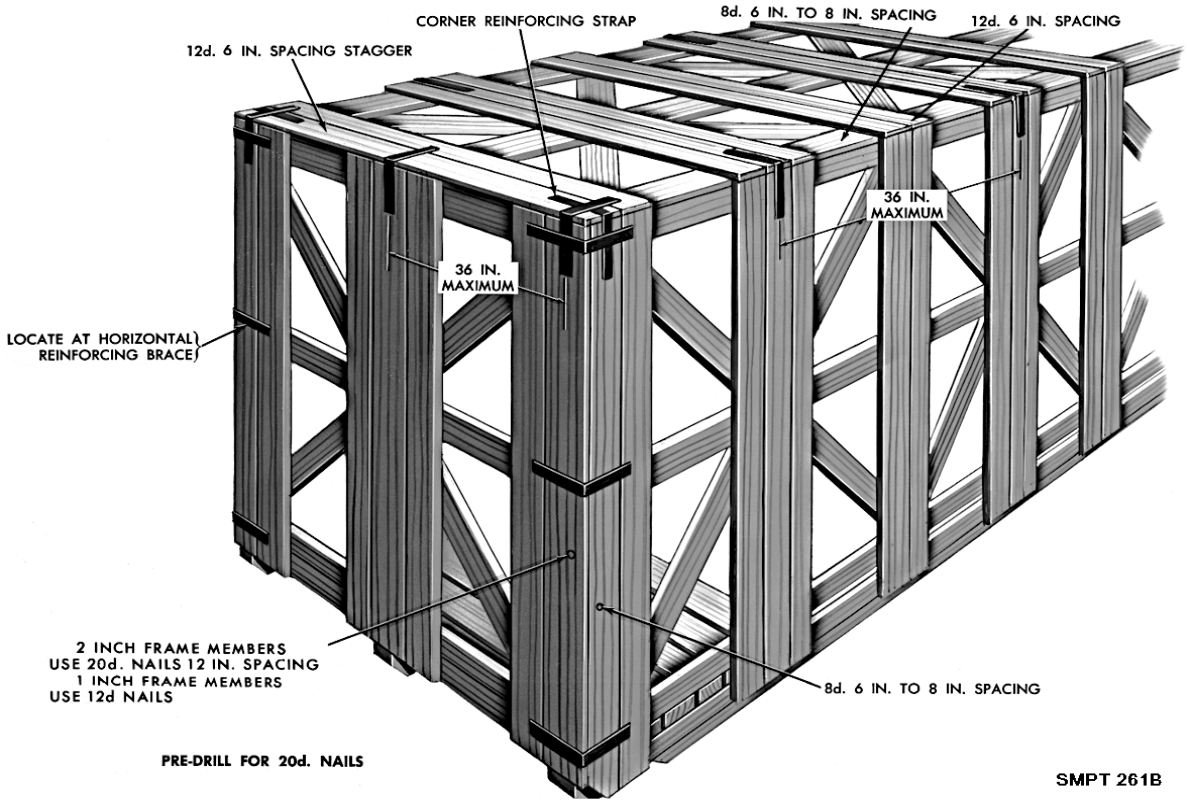


Figure 6-4. Assembly of open nailed crate (MIL-C-3774).

Large Open Crates

For military use, there are two kinds.

Nailed Crates

These crates are designed for a net weight ranging up to 12,000 pounds. The maximum size limit is not to exceed 16 feet in length, 8 feet in width, and 8 feet in height (fig 6-4).

Bolted Crates

These crates are designed for reuse with net weight ranging up to 16,000 pounds. These crates are designed with a size limit not to exceed 40 feet in length, 8 feet in width, and 16 feet in height (fig 6-5).

Sheathed crates

A sheathed crate is similar to an open crate except that the frame members are completely covered with sheathing material, such as lumber or plywood, fastened to the frame. This adds strength to the crate, prevents loss of contents, reduces pilferage, and prevents the direct entry of dirt, water, etc. The main difference between a nailed wood box and a sheathed crate is that the top, bottom, and side faceboards of a nailed wood box provides the main structural strength, whereas in a crate, the frame members sustain the load and provide the strength, Many sheathed crate designs exist in our military system; however, the designs selected for this section are considered to be the most widely and generally used (fig 6-6).

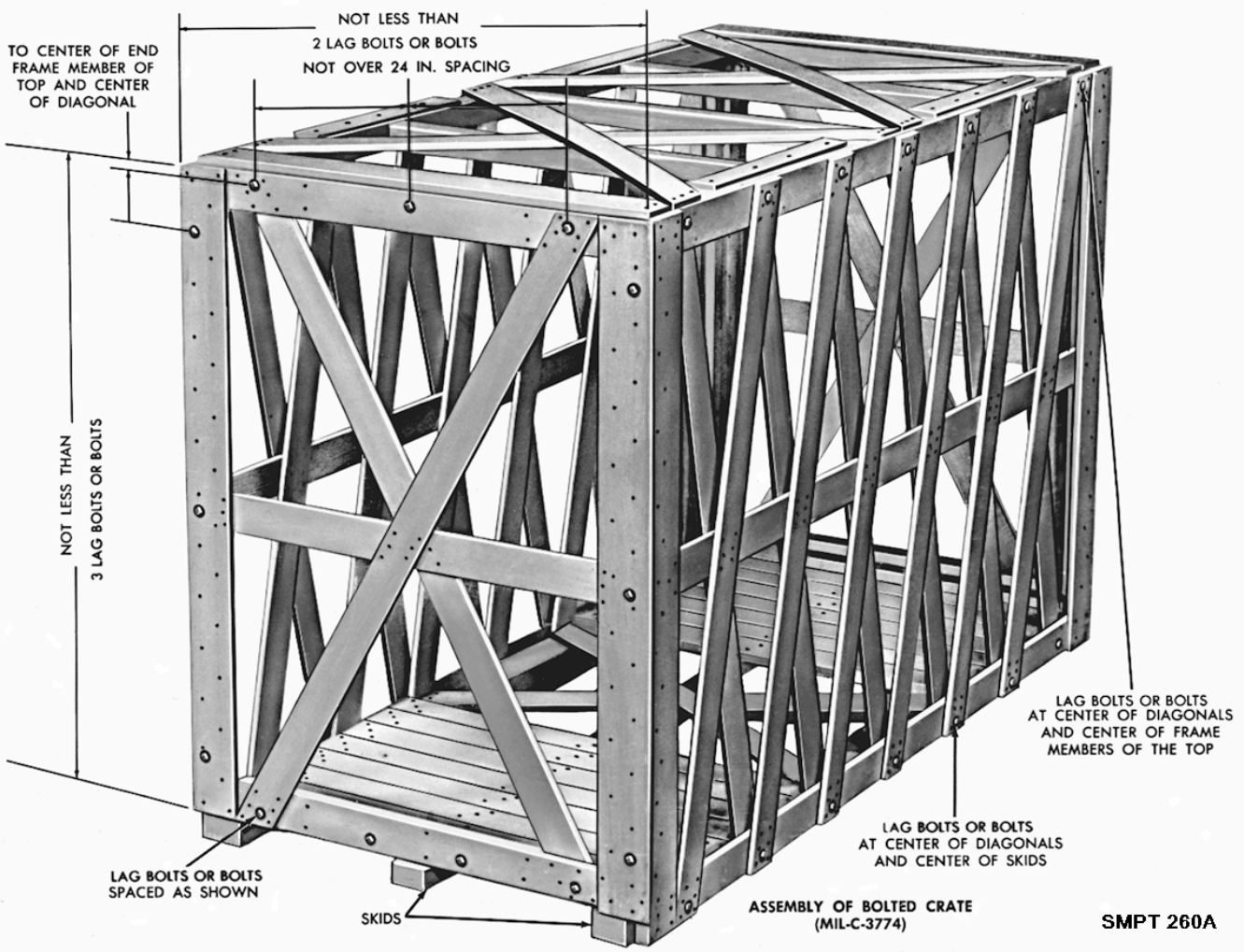


Figure 6-5. Assembly of open bolted crate (MIL-C-3774).

Sheathed Nailed Crates

These crates are not designed for reuse and are constructed in the same manner as bolted crates with minor exceptions. The crates should not exceed 30 feet in length, 9 feet in width, and 10 feet in height. The net weight of contents may range up to 30,000 pounds. These limitations may be exceeded, however, when the size and weight of the item require a larger crate.

Sheathed Bolted Crates

All bolted crates are designed for reuse. The size and weight limitations are the same as for the nailed crates.

Special Use Crates

Crates in this classification are of special design for specific items. These crates may be fabricated of metal or wood, either open, sheathed, nailed, or bolted. Crate dimensions and weight will vary depending upon the size, weight, and characteristics of the contents. Examples of special crates are illustrated in figure 6-7. The slotted angle crate (ASTM D6255) is an example of special metal crate which may be either open (Type I) or sheathed (Type II with either plywood, paper-overlaid veneer, or fiberboard. It may be fabricated without skids (Style A), or with skid blocks or skids with rubbing

strips (Style B). Both the open and sheathed Style A slotted angle crates are restricted to items not to exceed 200 pounds, with dimensions not to exceed 80 inches in length, 30 inches in width, and 48 inches in height, except when a specific design has been approved by the contracting activity. Both the open and the sheathed Style B carry up to 3,000 pounds and are limited to not over 30 feet in length, 4 feet in width, and 7 feet in height.

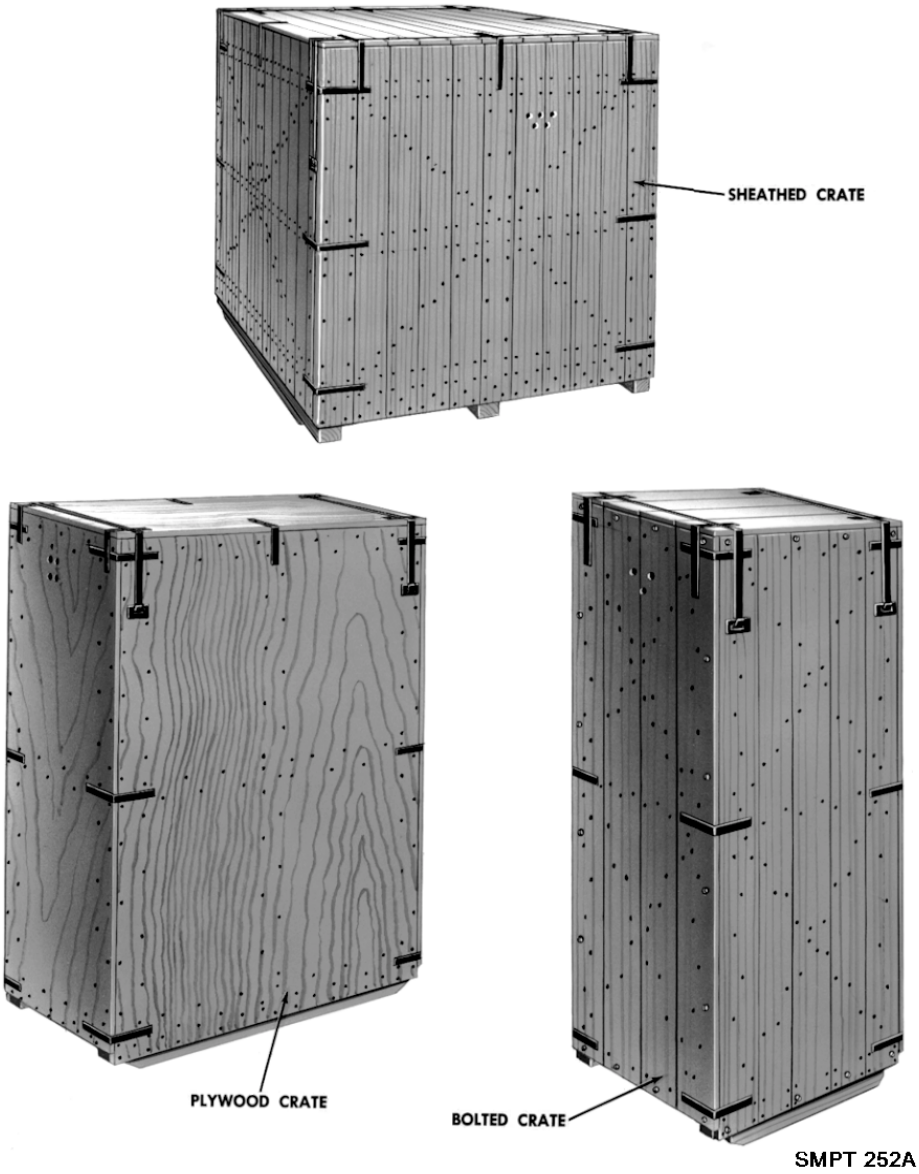


Figure 6-6. Sheathed crates.

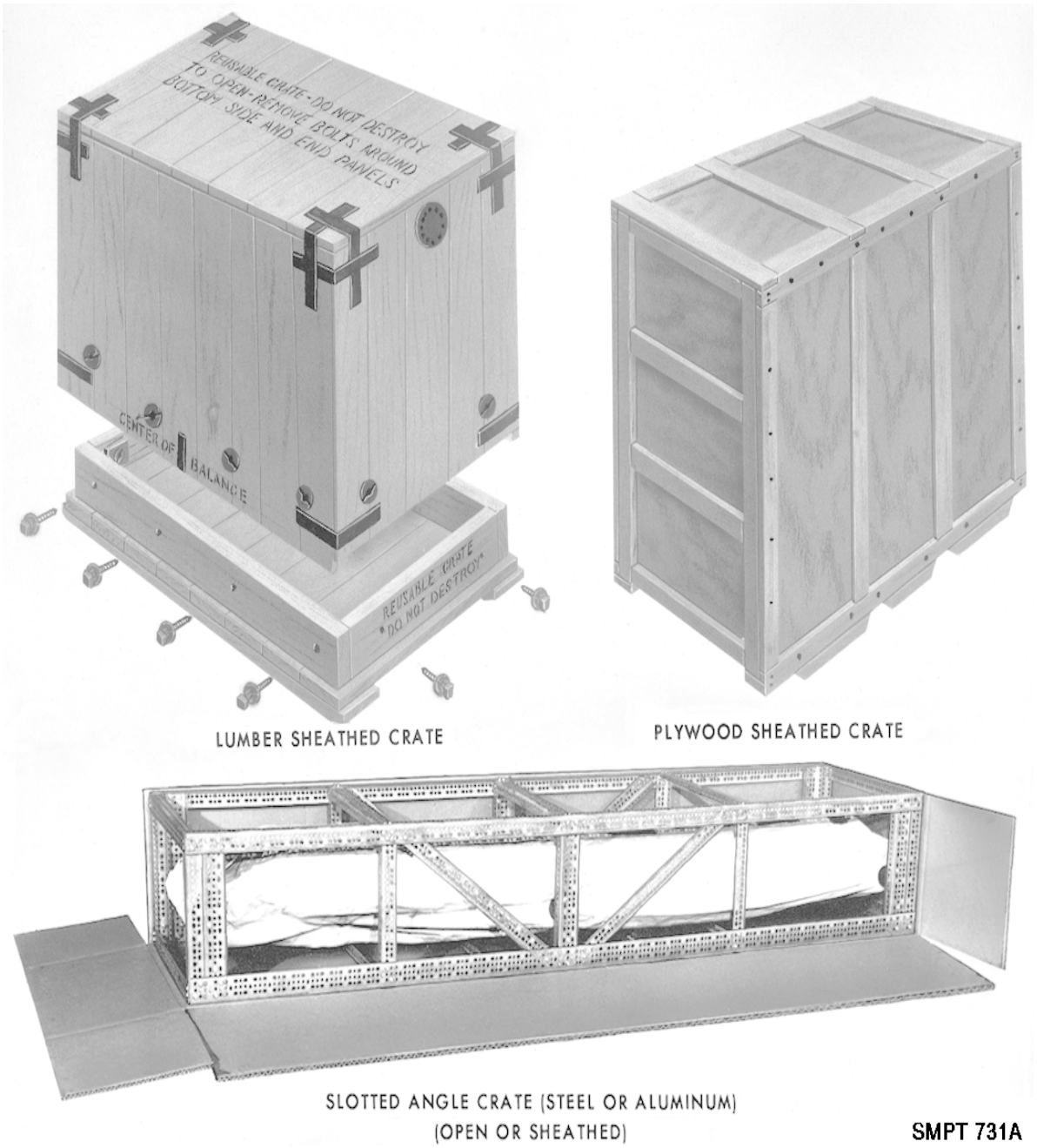


Figure 6-7. Special use crates.

Criteria for Crate Design

Crates are selected instead of boxes for several reasons. The item may be too large to be shipped in a box. The weight of the item may exceed the weight limitations of a box specification. The item may not require complete enclosure for protection, yet it may require crating to facilitate storage and handling. Crates provide better facilities for clearances, blocking, bracing, and anchoring of the item. To select the proper crate for the item or items to be packed, it is necessary to consider certain basic factors that may influence the selection.

Size and Weight

Basically, it is desirable to design a crate not to exceed 30 feet in length, 9 feet in width, and 10 feet in height, with a weight limitation not to exceed 11,200 pounds. This maximum size and weight is indicated because the length of 30 feet will permit lowering the crate through the average ship's hatch without excessive tilting. The 9-foot width and 10-foot height is designed for the average width and clearance limits for transporting by rail on a standard flat car. Taking the weight factor into consideration will permit ease of handling by the average ship's hoisting facilities.

Degree of Disassembly

When determining the size, weight, shape, and strength, considerations should be given to partial disassembly of the item or its components to reduce the overall size of the crate. However, do not disassemble the item to the point where special tools or personnel are needed to reassemble it.

Weight Distribution

In designing crates over 5 feet in length, weight distribution becomes an important factor. Whenever possible, the center of gravity of the contents should coincide with the geometrical center (center of balance) of the loaded crate.

Anchoring of the Contents

A thorough study of the contents should be made in order to insure that provisions are made for anchoring the contents within the crate to prevent damage during handling and shipment. When necessary, use cushioning and padding at points on the item where blocking, bracing, or strapping is used to prevent movement. Bolts, steel strapping, iron bands, rods and lumber holddowns are acceptable methods for anchoring and supporting the contents (fig 6-8). Some items are designed with packing and shipping in mind and are provided with holddown features. If the item does not have these characteristics, utilize the stronger areas of the item for anchoring.

Clearance

Normally, a minimum of one-inch clearance is required between the contents and the nearest framing member of the sides, ends, and top. This clearance allows for the distortion and vibration to which the crate may be subjected during rough handling and transit. Items that are fragile in nature, or items within floating bag barriers (submethods 53 and 43) require from 2 to 4 inches of clearance. Additional clearance may be required for shock mounted items. Through careful design, it is often possible to allow protruding points of the item to extend between the joists, or the joists may be spaced, within specified limits, to accommodate these protrusions.

Types of Bases

The selection of a skid or a sill base will depend on the physical characteristics of the item to be crated.

Sill Bases

Sill bases (fig 6-9) are designed for items that can be supported above their lowest point. Examples are transmission housing engines and vehicles with brake drums projecting below the frame or axles.

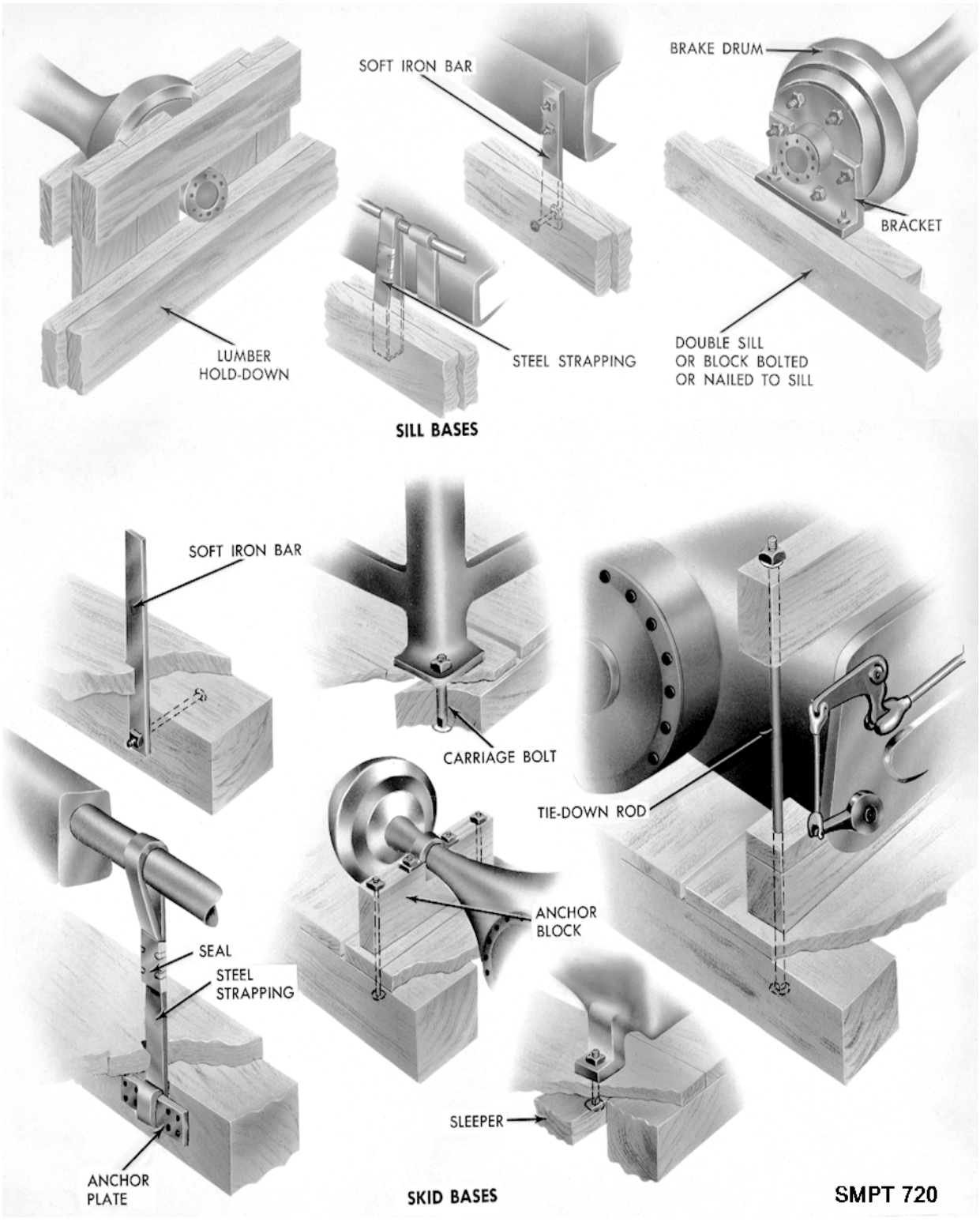


Figure 6-8. Methods of anchoring contents in crates.

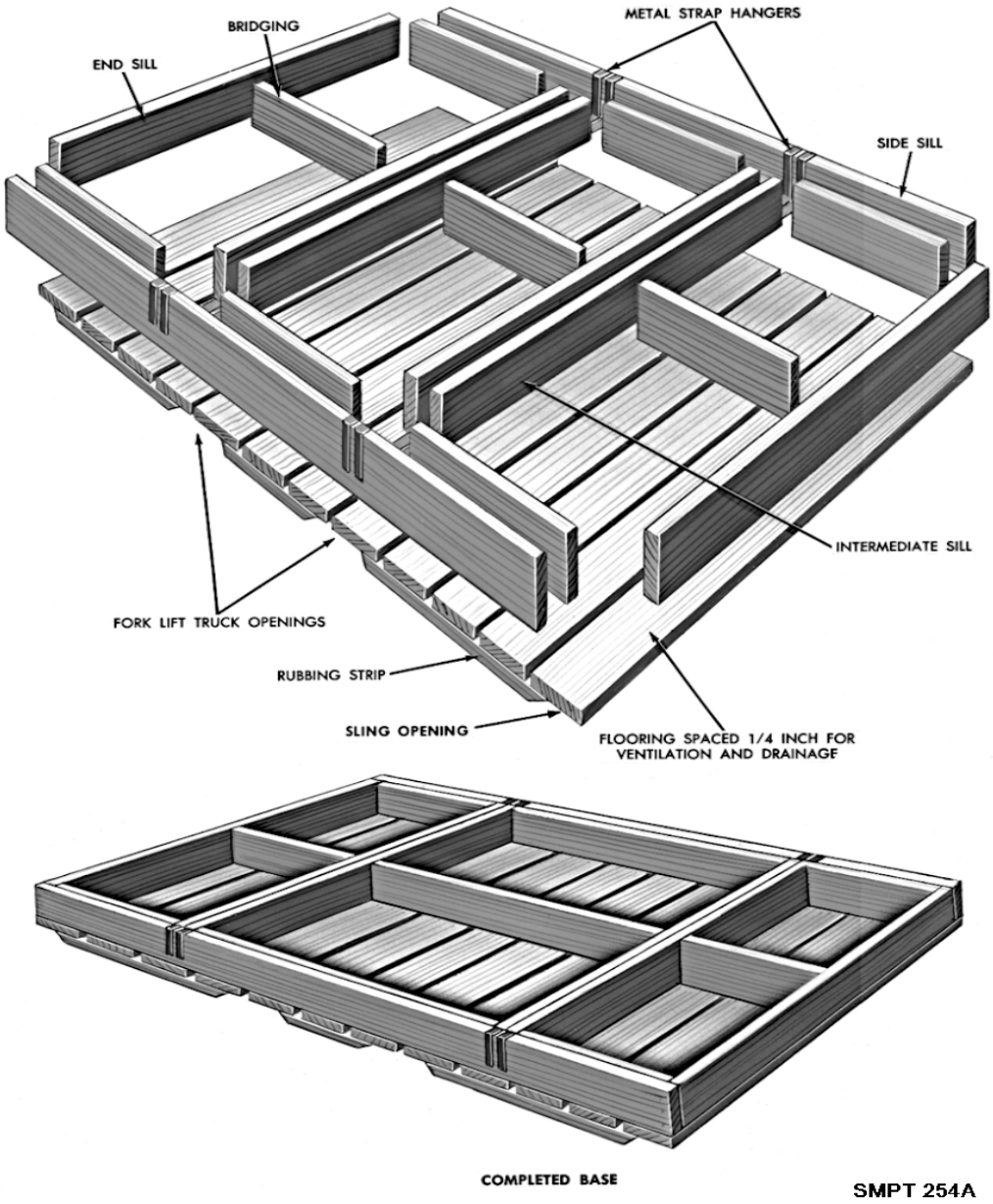


Figure 6-9. Sill base.

Skid Bases

Skid bases are designed to accommodate loads that can be supported on their lowest portion, or items that are made to rest flat on their bases. Skid-type bases are preferred in most cases; however, when the item must be supported above its lowest point, the use of a sill base will reduce the overall height of the crate. Savings in height should be more than 6 inches before substituting a sill base for a skid base (fig 6-10).

Engineering Factors in Crate Design

A crate is an engineered container. The use of sound engineering principles and actual tests of crates with contents has resulted in the following design requirements.

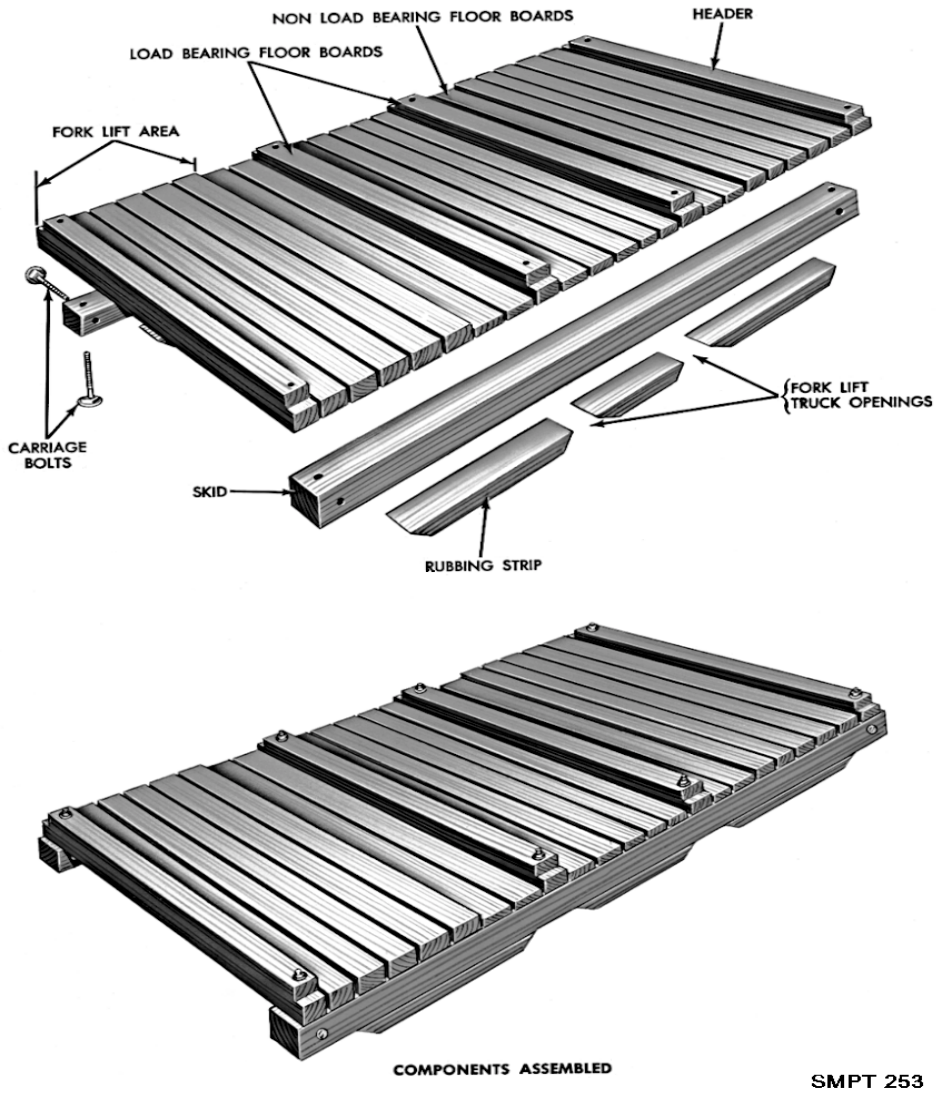


Figure 6-10. Skid base.

Tops

The top of a sheathed crate is designed to carry a uniform, well-distributed, superimposed load of 50 pounds per square foot. Top loading plus the span or width of the crate will determine the kind of top and the size of joist required to transfer the load to the sides.

Sides and Ends

For crate design, the side and end panels of sheathed crates are considered as trusses. The selection and size of members for the sides and ends are calculated on the bases of the span, height, and the amount of stress each member can withstand. These crate design factors are for sides having top loads, with dunnage, in the amount of 200 pounds per square foot, for net loads to 10,000 pounds. In addition, they may be designed for 400 pounds per square foot, for net loads over 10,000 pounds.

Bases

The base is treated as a unit and is designed to support the contents. In the engineering analysis, the skids of the base are considered as part of the lower frame members of the sides. The lower frame members and skids act together when the crate is lifted as a unit. This analysis allows the reduction of skid sizes, thereby saving materials and cube, but does not allow the handling of a loaded crate without the sides and ends in place. Skid sizes should be increased if it becomes necessary to raise or move the loaded crate without the sides and ends in place.

Load Factors and Handling and Storage Hazards

In addition to the external forces of superimposed loads and those imposed by the weight of the contents, crates are subjected to other hazards during handling and shipping. Crates are designed to be handled by forklift trucks, slings, and grabhooks (fig 6-11). In order to prevent crushing, the grabhook areas should be reinforced with additional material. For handling with forklift trucks, provisions are made to enter from the sides and ends without damaging the floorboards and contents. Forklift entry from the ends places stress on the headers, load bearing floorboards, and forklift members. Therefore, these members should be well secured with nails or bolts (fig 6-9 and 6-10).

Modes of Transportation

Crates may be shipped by rail, truck, plane, or ship. Some of the hazards involved in shipment are shock stresses and impact stresses resulting from sudden stops and starts. Vibration is also a shipping hazard. Crates shipped on open cars shall always be fastened securely to prevent any movement. In closed cars, there are several preferred methods of loading, some of which allow movement under controlled conditions. The preferred methods are the snubbed load, the floating load, and the rigid braced load. The method selected depends upon the fragility, size and shape of the item, and the center of gravity of the loaded crate. The snubbed load utilizes antiskid plates, while the floating load depends entirely upon the friction between the crate and the car floor. These loads are designed for items with a low center of gravity. The rigid braced loads utilize lumber and metal straps. This material should be applied in such a manner as to eliminate all movement. Shiploading involves stacking load stresses. Dunnage should be placed on top of crates, which have been designed to carry such loads.

Exposure and Storage

Sheathed crates will provide for long-term protection in exposed storage conditions. Open crates are designed for items that require very little protection from the elements. Sites selected for outside storage should be well drained in order to prevent water and moisture form entering the crate. Well constructed tops, proper drainage, and ventilation should prevent damage to the contents when stored under adverse conditions. Stacking stresses of superimposed loads are of major importance in storage. Open crates are designed to withstand superimposed loads in storage with additional dunnage placed on the top, transferring the load to the sides.

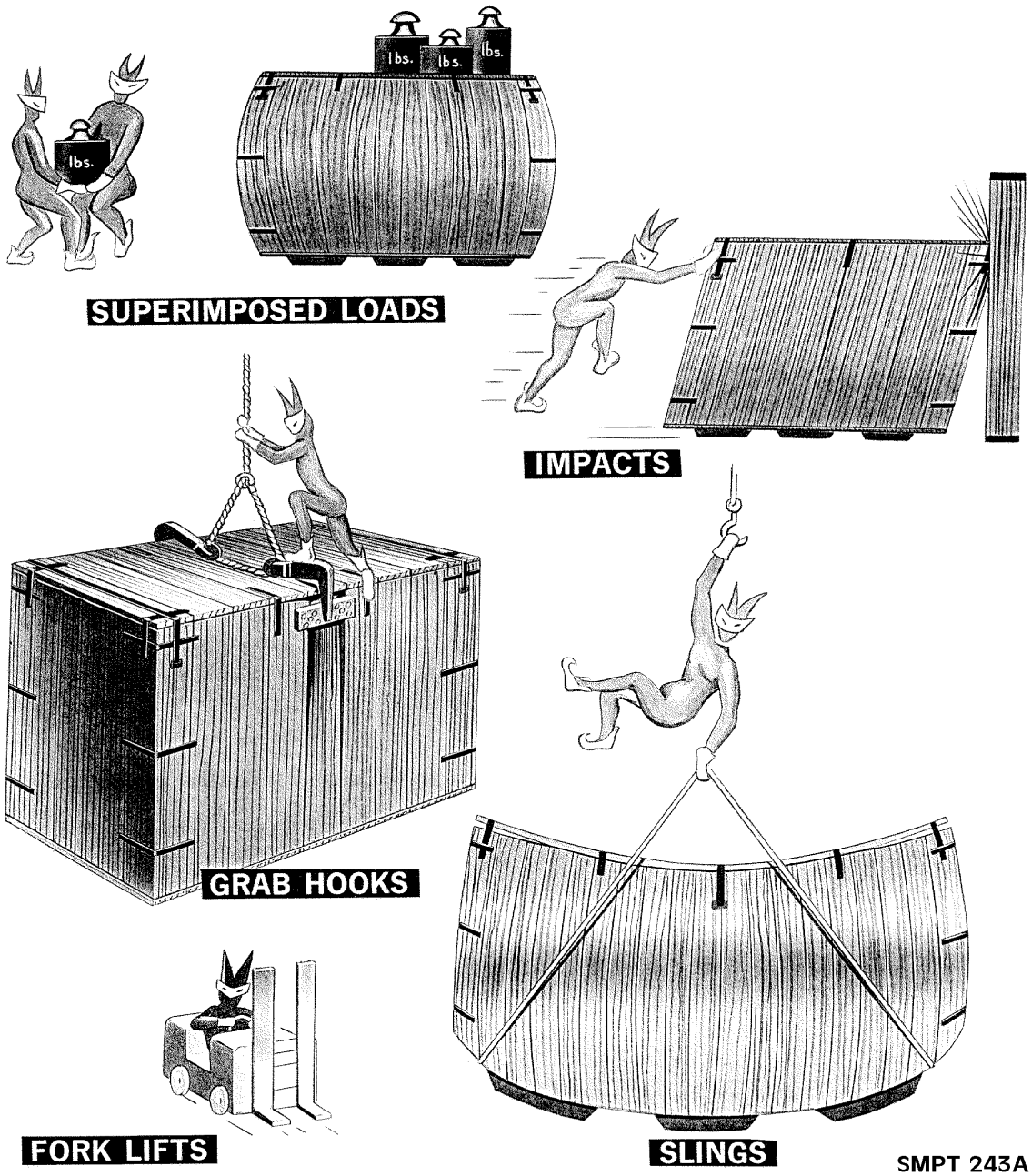


Figure 6-11. Resistance to forces.

CRATE MATERIALS

LUMBER

Lumber used in crate construction must meet the same rigid requirements as for other wooden containers. Lumber used in crate construction shall be free of defects that would materially weaken the container. Knots and divergence of grain (cross-grain) are probably the most common defects in lumber used for framing members, and will affect the strength of these members more than the sheathing boards. Knots or knot clusters that exceed one-fourth the

width of a structural member or that exceed one-third the width of a sheathing board, are prohibited.

Moisture content of lumber is an important factor and shall be not less than 12 percent nor more than 19 percent of its oven dry weight. Otherwise, shrinkage may occur and nail holding power may be reduced.

Divergence of grain (cross-grain) more than 1 inch in 10 inches in the length of a piece is prohibited.

The width and thickness of lumber used in fabricating crates are always minimum from a design standpoint. When nominal sizes are given in a crate specification, the actual minimum sizes will be as indicated in table 6-1.

Note. All lumber dimensions referenced in this section are nominal. Actual dimensions are so indicated when actual sizes are required.

Table 6-1. Minimum Thickness and Width of Lumber

Thickness in inches (smaller dimension)		Width in inches (larger dimensions)	
Nominal size	Minimum (actual)	Nominal size	Minimum (actual)
1	3/4	2	1-1/2
		3	2-1/2
2	1-1/2	4	3-1/2
3	2-1/2	5	4-1/2
4	3-1/2	6	5-1/2
5	4-1/2	8	7-1/2
6	5-1/2	10	9-1/2
7	6-1/2	12	11-1/2

Plywood (A-A-55057)

Plywood is used in crate construction for sheathing, for nonload bearing flooring, for tops, and gusset plates. While plywood is usually more expensive than lumber, it required no diagonals or crate liner material when used as sheathing, and a lighter, more economical crate may result from its use. Tests have shown that plywood is actually stronger than lumber, the dimensions being the same. When using plywood, select the standard size sheet stock that conforms closest to the crate dimensions, otherwise waste of material will result. The type of plywood selected will be on the basis of its intended use. Where prolonged exposure to the elements or attack by micro-organisms (mold, fungi, etc.) is expected, materials, must be selected that will withstand the extreme conditions.

Nails (ASTM F 1667-95)

Nails are used in the fabrication of the components for both nailed and bolted crates. They are also used in the assembly of nailed crates. The preferred types of nails used for crate assembly are the sinker, corker, or common. If these nails are not available, coolers or standard box nails may be used. Nails used for fastening plywood should be 14-gage with heads no less than 7/32-inch diameter.

Staples (ASTM F 1667-95)

Staples are sometimes used to fasten plywood sheathing to the framing members. When used for this purpose, staples should be made of 16-gage wire with a crown not less than one-half inch.

Bolts, Nuts, and Washers

Many types of bolts are used in crate construction. The most common types used are standard steel carriage, step, and machine bolts (fig 6-12). Bolt holes should be drilled the same size as the shank of the bolt. Plain washers should be used under the heads of the machine bolts and under all nuts. Special holding plates have been designed for use under the heads of square shank bolts to prevent turning. The use of plates is not mandatory. Countersinking of bolt heads is prohibited. The bolt threads projecting beyond the nut after tightening should be painted with hard drying preservative, unthinned paint or other similar material to prevent loosening.

Lag Bolts

Lag bolts are sometimes referred to as "lag screws". There are three types of lag bolts, Gimlet Point; Cone Point; and Cone Point, Fetter Drive (fig 6-12). There are two different types of heads, Hex head and Square head. Lag bolts are used to assemble the sides, ends, an tops of demountable crates. These bolts are prohibited for use as holddowns or to tie the headers and the floorboards to the skids. When using lag bolts for assembly, drill the lead hole to the same diameter as the shank, although the threaded portion may be larger than the shank. The size of the lead hole for the threaded portion will depend upon the group of wood used. When using lag bolts in soft woods, make smaller lead holes. Use plain washers under the heads and tighten firmly against the washer (table 6-2).

Note. Lag bolts should never be driven with a hammer. When power wrench is used, care must be taken that the bolts are not overdriven.

Nut Sleeve Assembly

A nut sleeve assembly, as illustrated in figure 6-13, may be used as an alternate for lag bolts in demountable crates. These bolts must be the same size as the fasteners they replace and are spaced the same distance apart.

Metal Strapping (ASTM D 3953 and ASTM D 4169)

Metal strapping is used for reinforcing crate corners, sill bases, securing tops, as lag bolts reinforcing straps for demountable crates, and for strengthening sill and load bearing headers for sill-type bases. It is also used to reinforce crate corners and the tops of open crates. Metal straps used for this purpose shall be Class 1 Type I or II, and not less than 3/4 x 0.028-inch (fig 6-14).

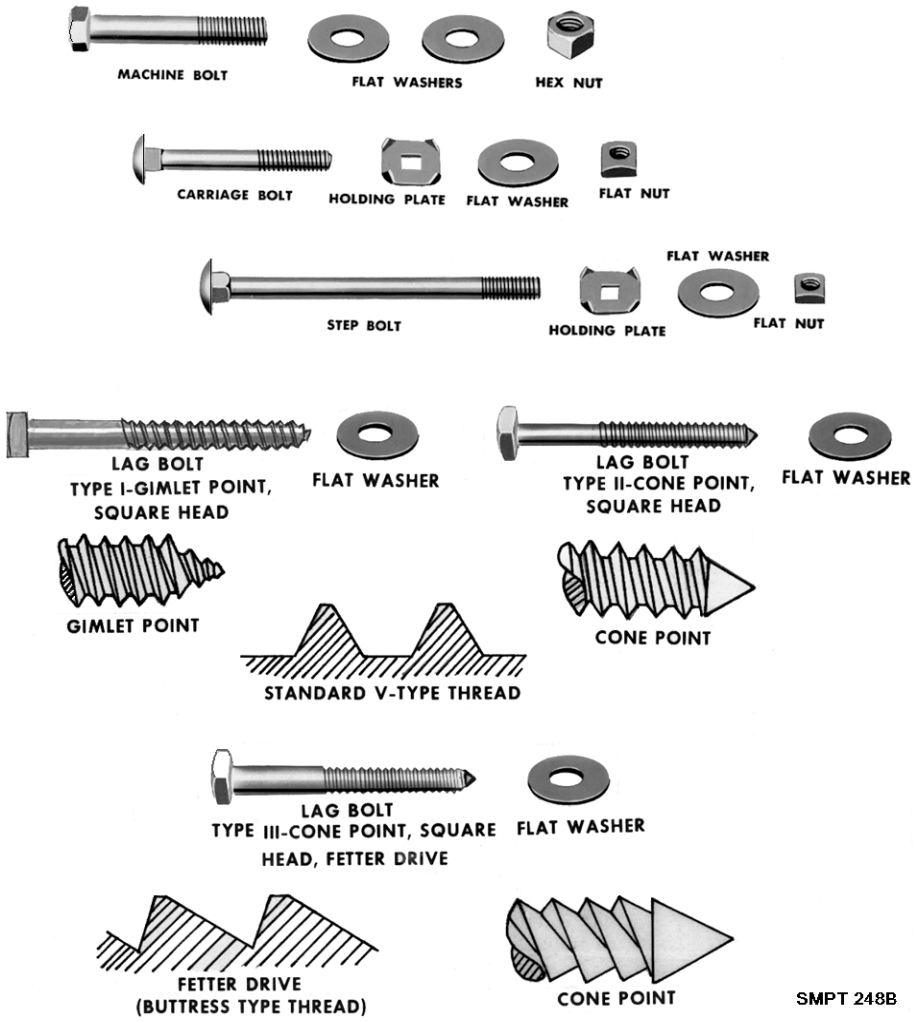


Figure 6-12. Bolts, screws, and accessories.

Table 6-2. Application of Lag bolts

Diameter of threaded portion of lag bolts	Diameter of lead hole	
	Groups I, II and III wood	Group IV wood
Inch	*Inch*	*Inch*
1/4.....	3/16	3/16
5/16.....	1/4	1/4
3/8.....	1/4	5/16
1/2.....	3/8	7/16
5/8.....	3/8	1/2
3/4.....	1/2	5/8

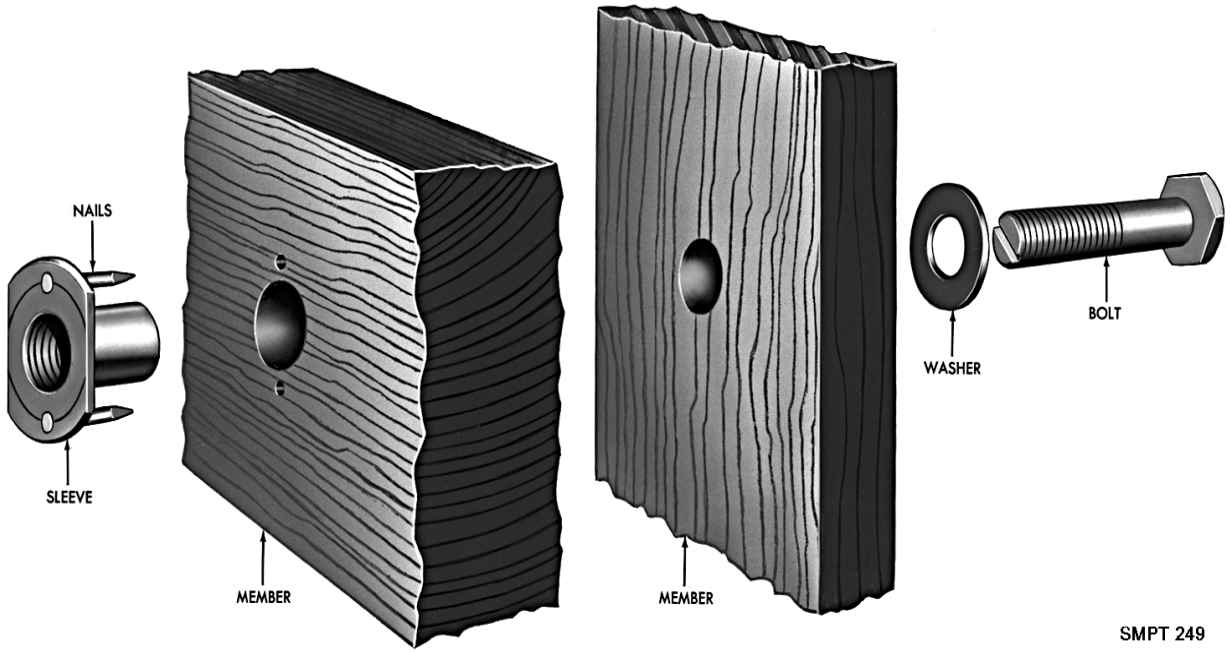


Figure 6-13. Nut sleeve assembly.

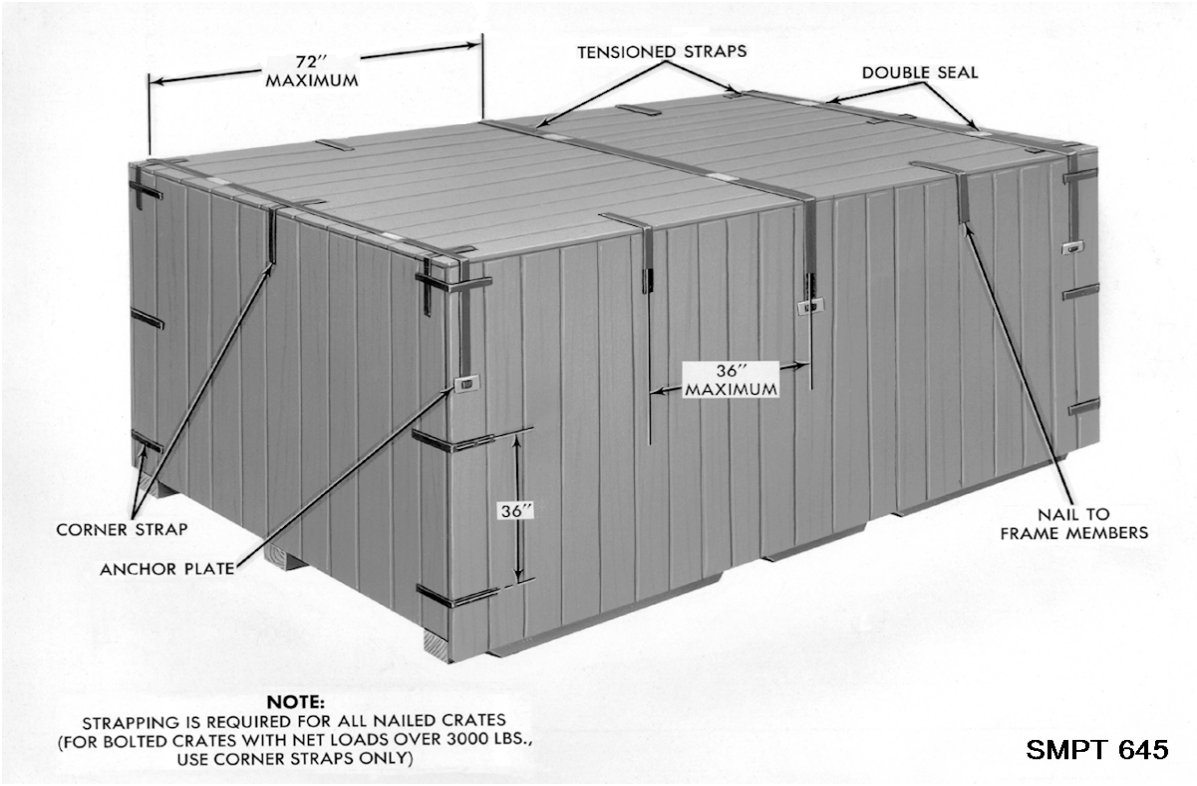


Figure 6-14. Tension and corner strapping.

Corner Straps

Metal strapping used for reinforcing tops, corners, and sill-type bases is usually annealed and predrilled for ease of application. This type of strapping is used on all nailed crates and on bolted crates with net loads over 3,000 pounds. The legs of the corner straps are usually 8 inches in length. They are nailed to the frame members with a minimum of three galvanized roofing nails, 1 1/4 to 1 1/2 inches long. The straps are spaced no more than 36 inches apart.

Tension Straps

Tensions straps are used to secure the top to the sides of the crate by anchor plates, which are nailed to the frame members. The straps are drawn tight with a tensioning device and held in tension with two seals. Tensions straps are spaced no more than 6 feet apart.

Lag Bolt Reinforcing Straps

This strap is fabricated from galvanized steel and is used on the side and end panels of many demountable crates to prevent the lag screws from tearing through the sheathing as the crate is lifted. The strapping material is prepunched or predrilled. Lag bolts 3/8 inch in length require 1 1/4 X 0.035 inch straps. For 1/2 inch and 5/8 inch lag screws, 2 X 0.050 inch straps are needed. Nail these straps to the lower inner face of the sheathing between the lower edge of the bottom frame member and the bottom of the sheathing. Locate them to coincide with the center of the skids and headers. Use clout or similar nails to secure the strapping. Space the nails a maximum of 2 inches on center and clinch at least three-fourths of an inch (fig 6-15).

Metal Hanger

Metal hangers are used for reinforcing joists of tops, load bearing headers, and intermediate sills on sill-type bases. Hangers are fabricated from steel straps 1 1/4 X 0.035-inch. The strapping material is prepunched or predrilled. When used to reinforce load bearing headers or intermediate sills, eightpenny nails are used to secure straps in place, followed by driving from two to four twentypenny nails into the end-grain of the holding member (fig 6-16).

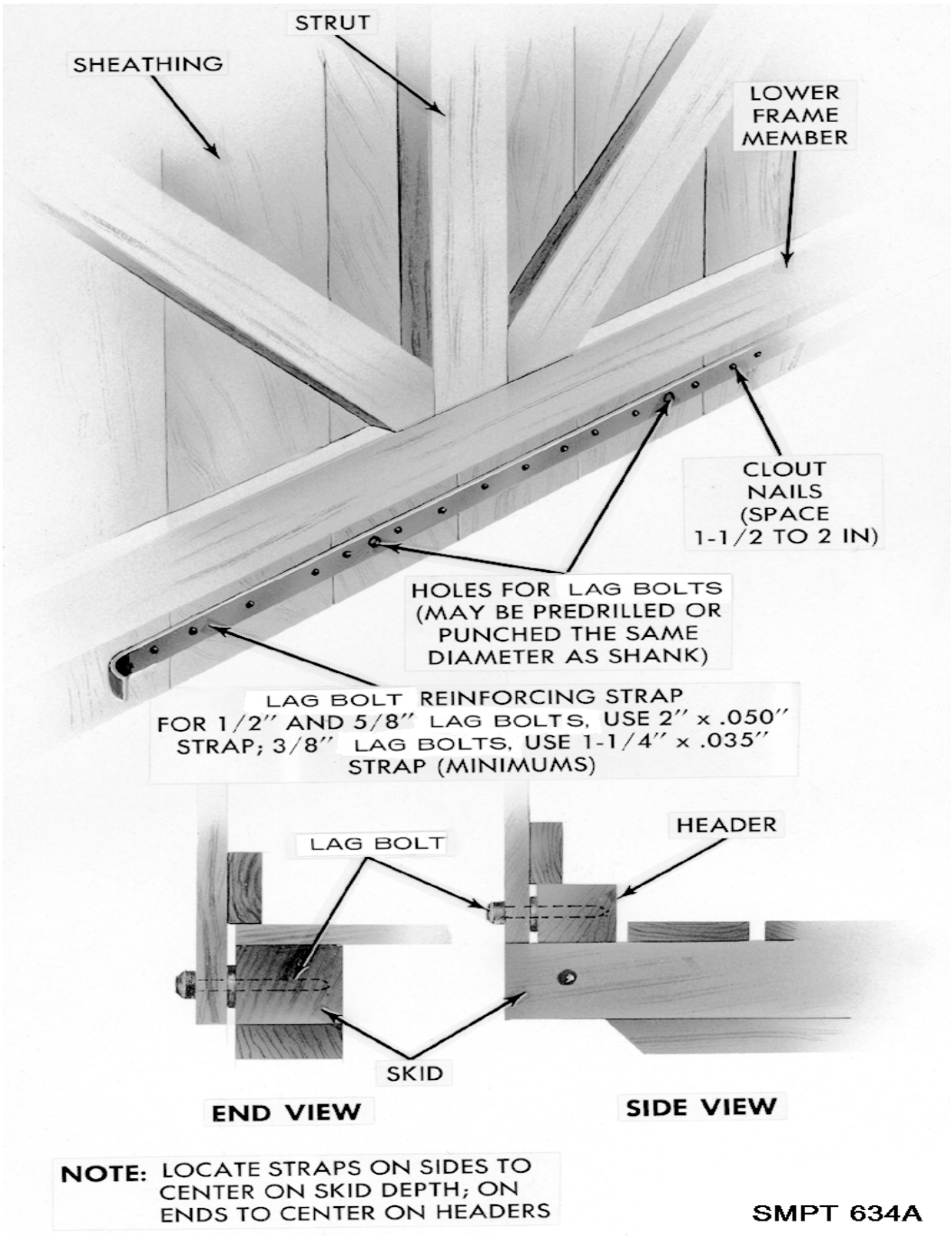


Figure 6-15. Lag bolt reinforcing strap.

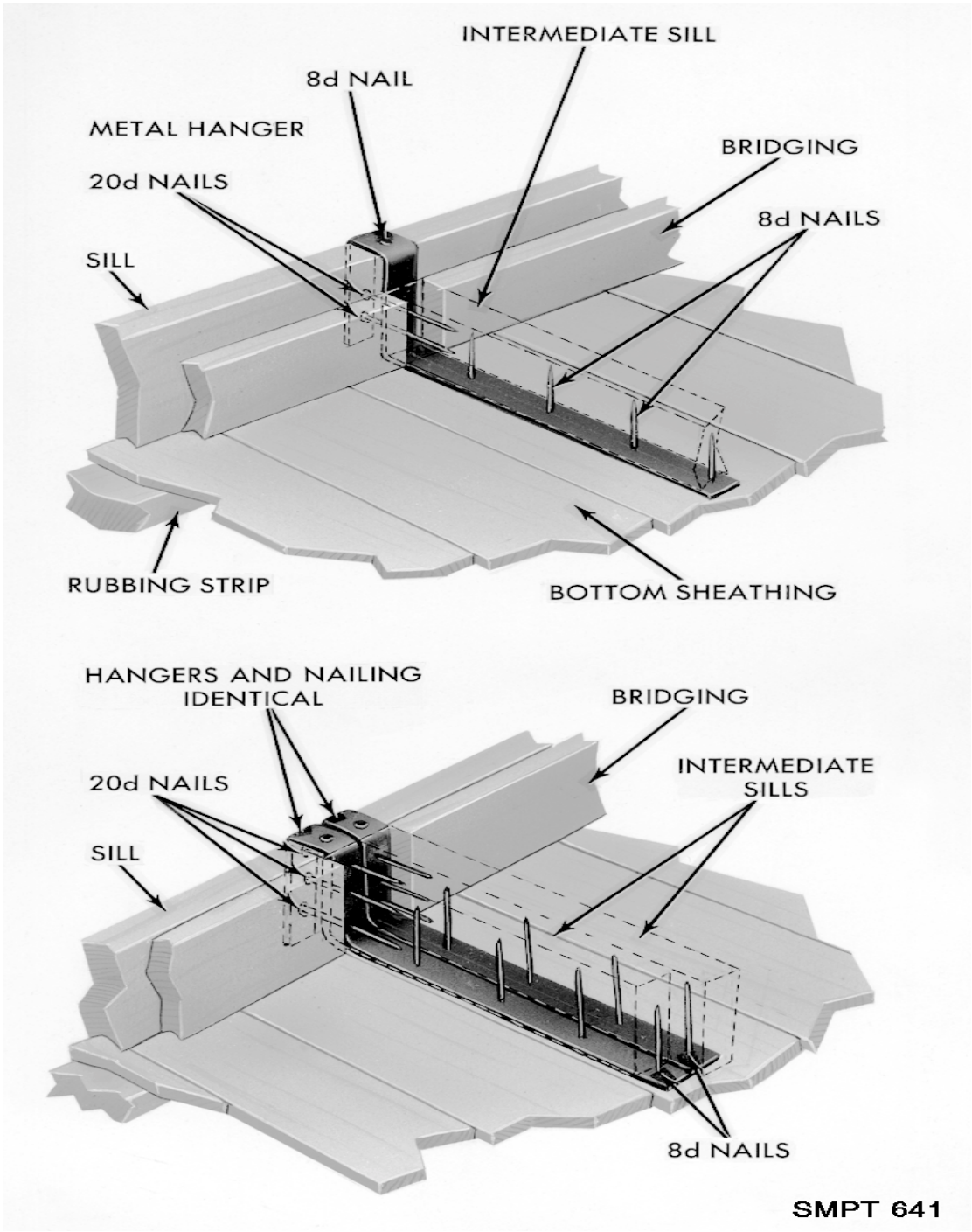


Figure 6-16. Use of metal hangers.

Sill Base Straps

In addition to the straps applied to other areas of the crate, sill bases must be reinforced with 3/4 X 0.028-inch metal straps (fig 6-17). Use a minimum of three galvanized roofing nails 1 1/4 to 1 1/2-inch long in each leg of the strap. Locate all nails to penetrate a framing member.

Waterproof Liners and Shrouds (PPP-B-1055)

This waterproof barrier material is made by laminating layers of kraft paper with asphalt. Seven different classes of materials may be used for crate liners. The most common classes used are E-1, E-2, and C-2. This material, when used as a liner, is placed horizontally between the sheathing and the frame members of the sides and ends. If more than one width of material is required, use a minimum of 4-inch shingle lap for proper drainage. The barrier should cover the entire framed area (fig 6-18) and 6-19). When vertical joints are required, the 4 inch lap will be located at a vertical member. Liners are not required for plywood sheathed crates. Interior shrouds, large bags, or envelopes fabricated from waterproof barrier material are used in open crates to cover items which require additional protection. All sharp projections of the item should be cushioned or padded to prevent puncturing the material. The class of material to use is optional, although the most common class is E-2. All joints in the material are made by using MMM-A-260 adhesive. Shrouds should hang free of the item to provide proper ventilation and should extend to within 6 inches of the bottom of crate. Material conforming to Specification L-P-378 may also be used for interior shrouds. This material is constructed of polyethylene and does not contain asphalt (fig 6-18 and 6-19).

Roofing Felt

Roofing felt is used in the construction of tops for sheathed crates. This material should have a smooth uncoated surface with a minimum weight of 45 pounds per square (a square is an area of 10 feet by 10 feet, or 100 square feet). The material is placed between the outer lumber sheathing and inner plywood sheathing of the top as illustrated in figure 6-60. When a joint is required, overlap the felt 4 inches and seal with a non-hardening caulk or mastic compound. As an alternative, polyethylene film, not less than 4 mils thick, may be used in place of roofing felt.

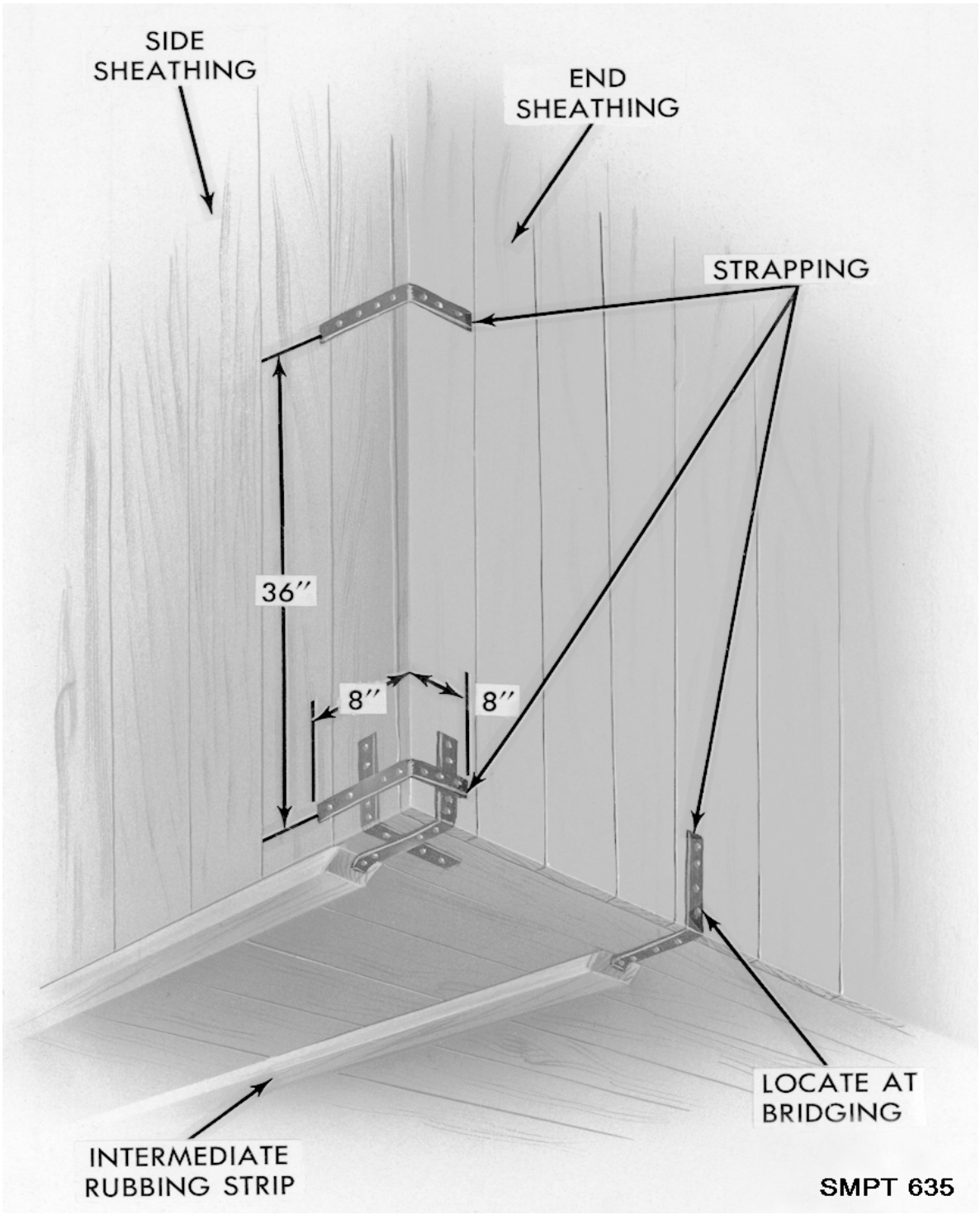


Figure 6-17. Application of strapping (sill base).

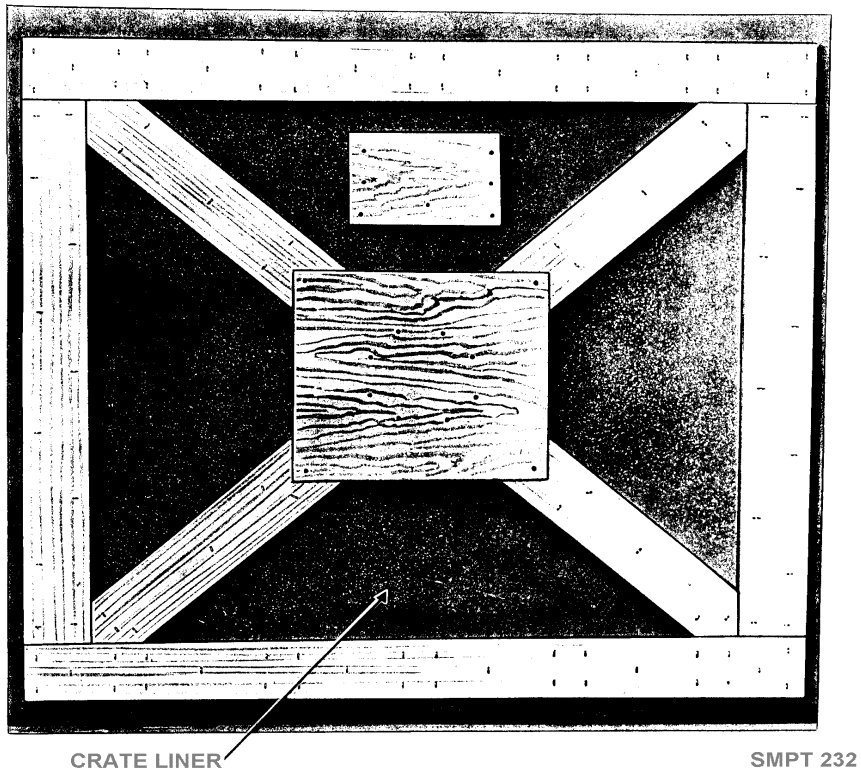


Figure 6-18. Crate liner.

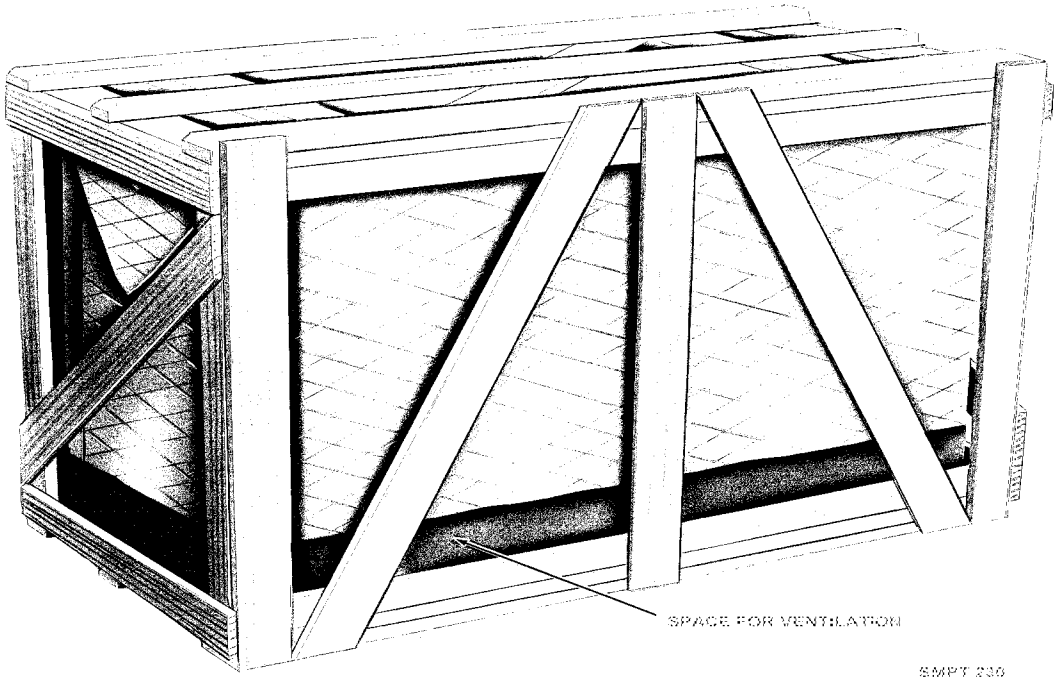


Figure 6-19. Interior shroud.

Screens and Ventilators

Screens are fabricated from heavy rust-resisting wire of 1/4 or 3/8 inch mesh and used over ventilating and drainage holes to prevent entry of birds, insects, rodents, or other animals. Ventilators fabricated from metal are sometimes used over ventilating holes. Some of the most common methods are illustrated in figure 6-49.

Inspection Doors

When inspection doors are required, they are made without cutting into the framing members. Doors are fabricated form the same material as the sheathing. Hinge at the top and fasten with lag bolts or wood screws at the sides and bottom (fig 6-20). Make cleats and stops from 1-inch material. Drill holes through the door and adjacent frame member to provide for a seal wire and lead seal bearing the inspector's stamp. The size and location of the doors will vary with the nature of the item.

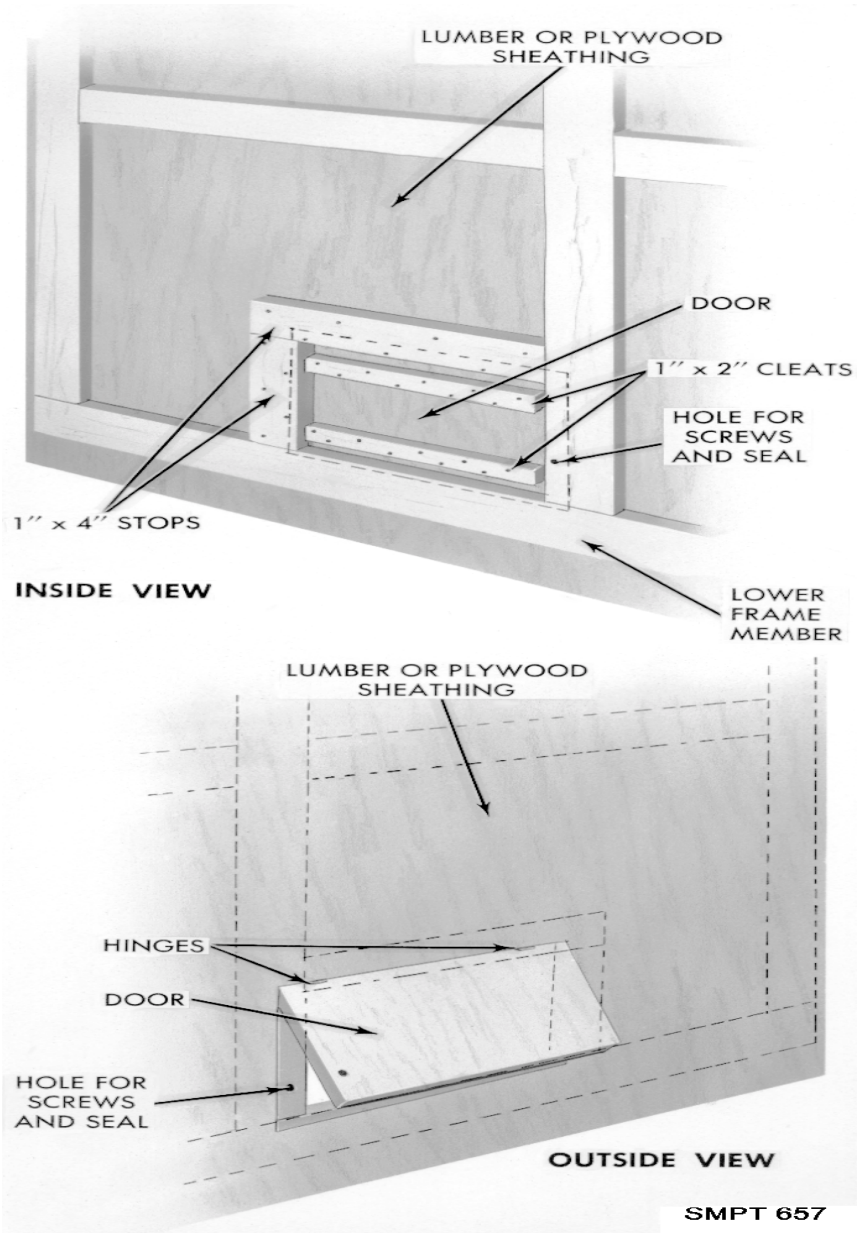


Figure 6-20. Crate inspection door.

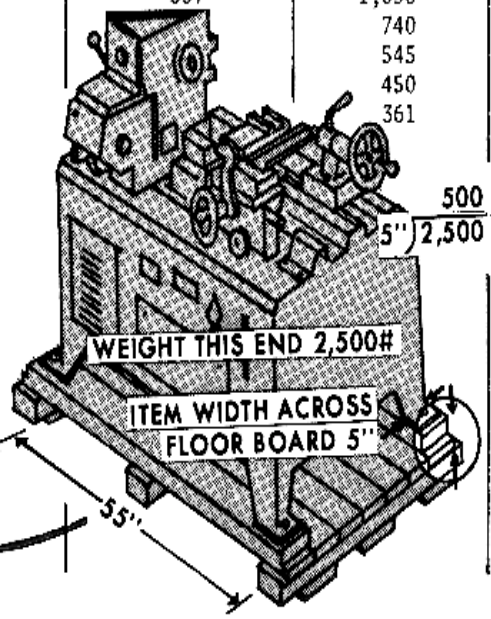
WOOD CRATES, OPEN AND COVERED, MIL-C-52950 (GENERAL)

CRATE DESIGN

Open wood crates described in this section are designed for general use and are employed for both domestic and oversea shipments. Only items which are not readily damaged from outside forces and which require limited protection should be shipped in open crates. Usually, items which are designed for outdoor use or of rugged construction are shipped in open crates. When there are a variety of items to be shipped, each crate will be designed for each item with the necessary clearance for blocking, bracing, and cushioning (fig 6-21).

ALLOWABLE LOAD PER INCH OF FLOORBOARD
WIDTH OF GROUPS I AND II WOODS (MIL-C-52590)

LENGTH BETWEEN SKIDS (IN.)	THICKNESS OF LOAD BEARING FLOORBOARDS (IN.)				
	1"	3"	4"	(6")	8"
	pound	pounds	pounds	pounds	pounds
12	50	557	1,090	2,690	4,680
18	34		740	1,790	3,140
24	25		545	1,350	2,330
30	20		450	1,150	1,870
36	17		361	895	1,560
42	15			767	1,335
48	12			671	1,170
54	11			596	1,039
(60)	10			(537)	936
66	9			488	850



[1]If group IV woods are used, the above allowable loads may be increased by 20 percent.
[2]Wood thicknesses shown are actual nominal thicknesses.

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Figure 6-21. Use of table to determine thickness of load bearing floorboards.

Classification

Crates fabricated or procured under MIL-C-52950 on the basis of weight, size, and construction features, as indicated in table 6-3.

Wood Requirements

The divergence of grain (cross-grain) should not exceed one inch in ten inches of length. Plywood, when used, will conform to A-A-55057.

Nails and Nailing

Nails used shall be sinkers, coolers, corkers, or common. For fastening covering materials to members, nails shall be not less than 1 inch long but shall not exceed the sum of the thickness of the covering material and member. Nails sizes specified for the fabrication of the various crates are based on Groups I and II woods.

When group III or IV woods are used, nail sizes may be onepenny size smaller than those specified. The patterns to be used for the nailing of two flat pieces of lumber shall conform to the details shown in figure 6-22. Unless otherwise specified herein, the following requirements shall determine size, placement, and quantity of nails.

- All adjacent crate members shall be securely fastened to each other, either directly or by means of the covering.
- All nails that are not to be clinched shall be cement coated or mechanically deformed (spiral or round threaded).
- Nails shall be driven through thinner member into the thicker member wherever possible.
- When the flat faces of pieces of lumber are nailed together and the combined thickness is 3 inches or less (except for top joints and covering material), nails shall be long enough to pass through both thicknesses and shall be clinched not less than 1/4 inch nor more than 3/8 inch.
- When the flat faces of lumber are nailed together and the combined thickness is more than 3 inches or when the flat face of one or more pieces is nailed to the edge or end face of another, nails shall not be clinched. The portion of the nail in the thicker piece shall not be less than 2 times the length of the nail in the thinner pieces for tenpenny nails and smaller, and not less than 1 1/2 inches for twelvepenny nails and larger.

    - When splitting occurs with the use of diamond point nails, the nails shall be slightly blunted. When blunting does not prevent the splitting, holes slightly smaller than the diameter of the nail shall be drilled for each nail.
    - Nails shall be driven so that neither the head nor the point projects above the surface of the wood. Occasional overdriving will be permitted, but nails shall not be over-driven more than one-eighth the thickness of the piece holding the head.

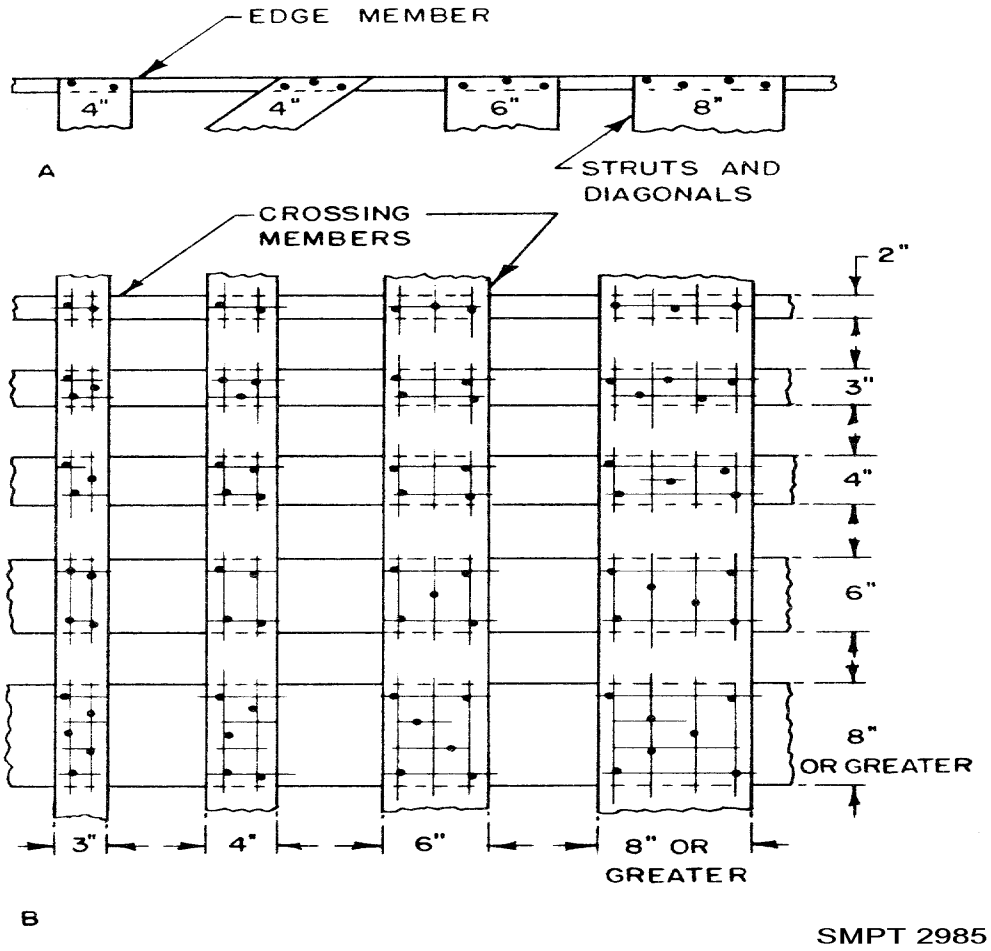

Figure 6-22. Nailing patterns. (All widths nominal). Similar patterns shall be used when boards cross at angles other than 900.

Table 6-3. Classification of MIL-C-52950 Crates

Type	Style A - Heavy Duty				Style B - Light Duty			
	Maximum net load	Maximum Inside Dimensions			Maximum net load	Maximum Inside Dimensions		
		Length	Width	Height		Length	Width	Height
	(pounds)	*(feet)*	*(feet)*	*(feet)*	*(pounds)*	*(feet)*	*(feet)*	*(feet)*
I	250	4	3	3	200	4	3	3
II[1]	1000	12	4	2	NO STYLE B			
III	NO STYLE A				No load or size restriction except as limited by handling methods.			
IV	1000	6	4	4	NO STYLE B			
V[2]	2500	12	6	6	4000	32	6	10

[1]Items such as ladders, tubing, and extrusions weighing less than 200 pounds and not exceeding 20 feet long, 3 feet wide, and 2 feet high may be packed in Type II crates.
[2]Type V, Styles A and B crates shall be further classified as being nondemountable or demountable. Type V, Style B crates may be open or covered.

- Nails shall be positioned not less than the thickness of the piece from the side end nor less than one-half the thickness of the piece from the edge of the lumber whenever possible. Nails driven into the side edge of the lumber shall be centered on the side edge.
- When two members having parallel grain are attached, the number of rows of nails shall be determined by the nominal width of the surfaces in contact, one row for widths up to and including 2 inches, two rows for widths greater than 2 inches but not greater than 6 inches, and three rows for widths over 6 inches.
- When plywood is nailed to cleats, nails shall be spaced not more than 4 inches apart on centers placed in staggered rows which are less than 1 3/4 inches apart or less than 3/4 inches from the edge of the cleat.

Staples

The crown of the staples used for fastening covering materials for frame members shall be not less than 3/8 inch. The length of the staples shall not exceed the sum of the thicknesses of the covering materials and the frame member; however, staples shall be not less than 1 inch in length.

Bolt application

Holes shall be prebored to receive carriage bolts and shall be the exact diameter of the bolt. The lead holes for lag bolts shall be the same diameter as the shank, even though the threaded portion may have a greater diameter than the shank.

Splices

Splices and butt joints made in frame members and skids of long crates shall be as shown in figure 6-23.